ENGINEERING REPORT

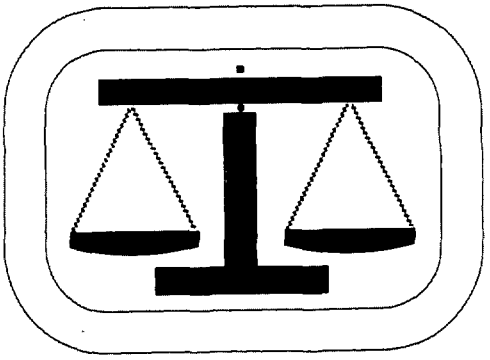
for

Contract DACW-33-81-C0030

Work Order Number 1

Subsurface Investigation

Sandwich, Massachusetts



BRIGGS

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1.1 Authorization

The work reported herein was peformed under contract DACW 33-81-C-0030, Work Order No. 1 dated 4 February 1981.

1.2 Purpose

The purpose of the subsurface investigation was to determine the subsurface conditions in the vicinity of the proposed bulkhead rehabilitation project at Sandwich, MA.

1.3 Scope of the Investigation

Six test borings were drilled at the locations shown in Figure 1 between 12 February and 5 March 1981 by Briggs Engineering and Testing Company. The field boring logs are included as Appendix A to this report.

BORING A Boring A was a drive sample boring advanced to a depth of 70 ft. The borehole was advanced to a depth of 54 ft using HW casing and a 2 1/2 inch I.D. by 5 ft solid spoon sampler. A concentration of cobbles was encountered between the depths of 54 to 56 ft. The hole was advanced from 54 to 56 ft using a 5 ft NX core barrel and from 56 to 70 ft using BW casing and the 1 1/2 inch I.D. by 5 ft solid barrel sampler. Difficult driving was encountered by 56 and 63 ft below ground surface.

BORING SP-1 Boring SP-1 was a drive sample boring advanced using a 1 3/8 inch I.D. by 24 inch split barrel sampler and NW casing. Samples were taken every 5 ft or, where there was a change in soil state, to a depth of 52 ft.

BORING B Boring B was a drive sample boring advanced to a depth of 69 ft. The borehole was advanced using the 2 1/2 inch I.D. by 5 ft solid spoon sampler from 0 to 36 ft and from 45 to 50 ft and the 1 1/2 inch I.D. by 5 ft solid spoon sampler from 36 to 45 ft and 50 to 69 ft below ground surface. HW casing was used from 0 to 45 ft and BW casing from 45 to 65 ft. A concentration of cobbles was encountered between the depths of 35 and 36 ft. It was very difficult to advance both the sampler and casing from 55 to 69 ft.

BORING C Boring C was a drive sample boring advanced to a depth of 40 ft. The hole was advanced using HW casing and a 2 1/2 inch I.D. by 5 ft solid spoon between the depths 0 to 20, and 25 to 30 ft, a 2 inch I.D. sample from between 30 to 35 ft, and a 1 1/2 inch I.D. sampler from 20 to 25 ft, and 35 to 40 ft. All three samples were employed in an attempt to improve sample recovery.

BORING D Boring D was a drive sample boring advance to a depth of 69 ft. The borehole was advanced using NW casing and the 2 1/2 inch I.D. by 5 ft solid spoon sampler from 0 to 10 ft, the 2 inch I.D. sampler from 10 to 55 ft and the 1 1/2 inch I.D. sampler for 55 to 69 ft. Due to the extreme density of the soil it was very difficult to advance the hole between the depths of 55 and 69 ft.

BORING E Boring E was a drive sampler boring advanced to a depth of 69 ft. The borehole was advanced using NW casing and the 2 1/2 inch I.D. solid spoon sampler from 0 to 5 ft, the 2 inch I.D. sampler from 50 to 70 ft. The hole was moved 5 ft from its original location after encountering a boulder at a depth of 17.5 ft.

1.4 Subsurface Materials

Our knowledge of the subsurface conditions is based on the results of the field investigations described in Section 1.3.

The following subsurface strata were encountered when the borings were drilled at the site:

a. Fill, up to 10 feet thick was encountered at the ground surface. The fill consisted primarily of very loose to medium, brown sands and gravelly sands with some soft sandy silt encountered in Boring D.

b. Interbedded sequence of organic silty clays, peats and sand of marine origin underlie the fill material in the eastern half of the site. This sequence ranges in thickness from 8 to 15 feet and lies 3 to 6 feet below ground surface.

The organic silty clay is slightly plastic, gray and ranges in consistency from soft to very soft. It contains varying amounts of plant material and decayed organic matter, and has a sulfurous odor. Undrained shear strengths as measured in the field with a pocket penetrometer ranged from 0.25 to 1.00 TSF. Occasional pebbles and a cobble were encountered in the silty clay in Boring E between 17 and 20 feet below ground surface.

The peat is a very soft, brown fibrous material and contains about 10 to 20 % silty clay. The sand lenses are composed of loose, gray, coarse to fine sand and are typically 2 inches or less in thickness.

c. Gray, loose sand (SP-SM) underlies the fill material in the western portion of the site and underlies the interbedded clays, peats and sands in the eastern portion of the site. The sand lies 10 to 14 feet below the ground surface and varies in thickness from about 2 to 5 feet. The sand is poorly graded, mostly fine and contains some silt and gravel.

d. Silty sand (SM) underlies the sand in the western end of the site and the interbedded sequence in the eastern end of the site. The silty sand was not encountered in the central portion of the site. The silty sands were encountered 15 to 20 feet below the ground surface and vary in thickness from 0 to 20 feet.

e. Sandy silts (ML) and clayey silts (ML) overlie the glacial outwash in the western portion of the site. These soils are typically slightly plastic, stiff and gray. Undrained shear strength as determined by the pocket penetrometer ranged from 2.0 to 2.5 TSF. The silty sands lie approximately 15 to 35 feet below ground surface and ranges in thickness from about 0 to 15 feet.

f. Glacial outwash underlies the entire site area. The outwash ranges in thickness from 10 to 40 feet and lies 23 to 50 feet below ground surface. The outwash is thinnest and deepest in the western end of the site as indicated by Boring A and thickens to the east.

The outwash is composed of a stratified sequence of silty sands, sands, gravelly sands and occasional silts. The bedding is typically massive and the best stratification is displayed in samples obtained from Borings D and E. The materials is very dense as indicated by the difficulty encountered in driving both the solid spoon sampler and casing. Several spoon tips were damaged during driving and had to be discarded. Isolated cobbles were encounted at several locations. Approximately two feet of cobbles were encountered between 54 and 56 feet below ground surface in Boring A. No boulders were encountered in the glacial outwash.

g. Very dense, brown, fine sand underlies the glacial outwash. The sand was encountered approximately 45 to 68 feet below ground surface. On several occasions it was not possible to drive the solid spoon sampler the full five feet before encountering refusal (30 blows for 0.1 ft of penetration) due to the extreme density of the soil. It was also very difficuly to advance the casing. The sand was poorly graded, and mostly fine. There was less than 5 % gravel in any sample and typically between 5 and 10 % non-plastic fines.

1.5 Groundwater

The depth to the water table was monitored in each boring with simultaneous readings of the tide taken. Tidal readings were measured with respect to the top of the wooden walkway which runs along the top of the existing bulkhead. Water readings are summarized in the last page of each field log.

1.6 Quality Assurance

We hereby certify that the following equipment and procedures were used to perform the subsurface investigation described in this report.

A. General. All work was conducted in accordance with the procedures outlined in ASTM D-1586 except as noted below.

B. Records. NED Forms 58 and 58A, dated March 1971 entitled "Field Log of Test Boring" and Form 59 entitled "Subsurface Water Observations" were used to record pertinent data including the following:

1. Hole number and location.

2. Make and model designation of equipment.

3. Type of drilling and sampling operation by depth.

4. Dates and time by depth when drilling and sampling operations were performed.

5. Depths at which samples or cores were recovered or attempts made to sample or core including top and bottom depth of each run. Classification of the soil in accordance with ASTM D-2487 and D-2488. Indication of penetration resistance such as drive hammer blows given in blows per penetration depth for driving sample spoons.

6. Length of sample recovered per run.

7. Simultaneous readings of the depth from ground surface to the water surface in each boreholes and tidal measurements.

8. Depth to bottom of hole.

C. Equipment. The equipment and type of tools used are described below.

1. Core Drills. The core drills were modern, hydraulically driven rotary head manufactured by the Acker Drill Co.

2. Samplers. The equipment employed to obtain soil samples was the solid barrel sampler type with a ball check head in sizes 2-1/2, 2 and 1-1/2 inch ID x 5 ft with spring or flap type retainers. Split barrel sampler were 1-3/8 inch ID by 2 inch OD by 24 inches in length.

3. Drive Hammers. Drive hammers for advancing the solid barrel sampler weighed approximately 300 lbs. Drive hammers for advancing the split spoon sampler weighed approximately 140 lbs.

4. Core Barrels. A NWX core barrel was used. The barrel was equipped with a diamond impregnated bit.

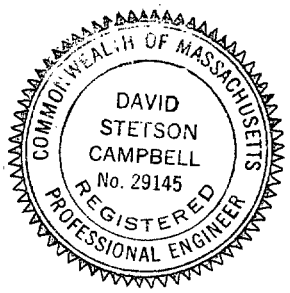
5. Casing and Rods. HW, NW, and BW flush joint casing was used to keep the boreholes open. The casing size was reduced depending on the degree of difficulty in advancing the borings. AW drill rods were used.

D. Procedures

1. Drilling was accomplished by continuous sampling in which a 2-1/2, 2 or 1-1/2 inch ID x five foot solid sample spoon was advanced below the bottom casing into undisturbed soil by the impact of a hammer weighing approximately 300 pounds falling 18 inches. The sample spoon was reduced from the initial 2-1/2 inch starting size to 2 inch or 1-1/2 inch size depending on the degree of difficulty encountered in advancing the boring.

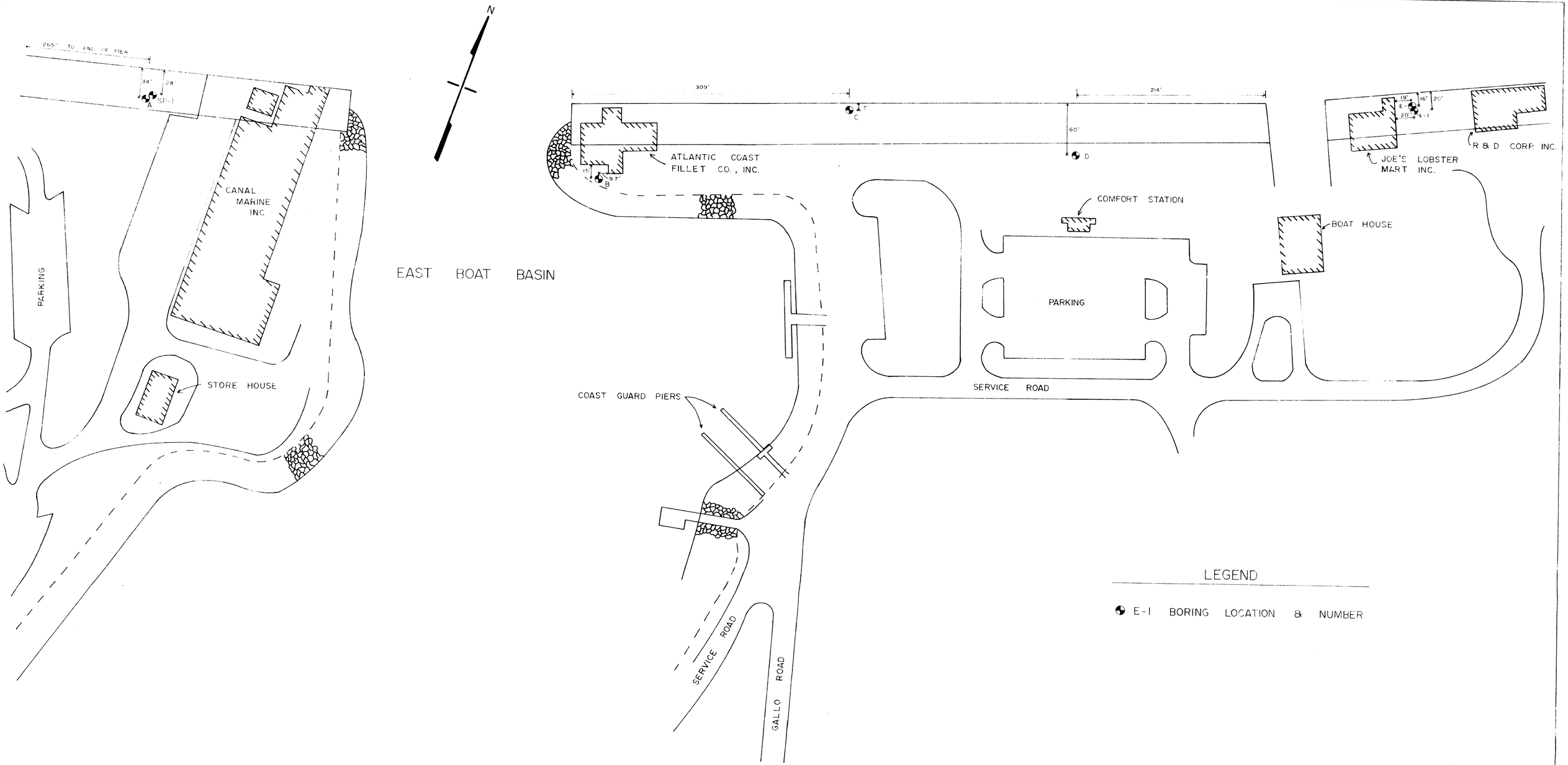
2. The sample spoon shoes were kept reasonably sharp at all times. Dull, bent, or otherwise damaged samplers were not used. Sampling was accomplished to a depth of not more than five feet below the bottom of the casing, after which the casing was advanced to the previously sampled depth and cleaned out using appropriately sized roller bits and side discharging chopping bits. When sampling was conducted below the water table, the casing was kept filled with water.

3. Samples were classified in the field by a graduate engineer immediately following the taking of the sample. Classification was in accordance with ASTM D-2487 and DD-2488. Representative samples were taken from each sampling run and placed in 16 oz. glass jars with hermetically sealed lids. Jars were labeled with sample number, sampling interval, boring number, date, location, penetration resistance and soil description. A chain of custody log was maintained documenting custody of the samples between the field and transportation and delivery to the laboratory.



Certified 6 March 1981

David S. Campbell P. E.
Massachusetts No. 29145



LEGEND

E-1 BORING LOCATION & NUMBER

BRIGGS
ENGINEERING · TESTING

SANDWICH BULKHEAD REHABILITATION

TITLE: BORING LOCATION PLAN		DWG. NO. 1
SCALE: 1" = 50'	DATE: 3/10/81	
DRAWN: J C C	CHECKED: N A L.	SHEET OF